4.0. What Type of Monitoring Do I Need to Do and How Do I Do It?

The type of monitoring required by the landowner depends upon the Waiver category that the activity is covered by and the threat to water quality posed by the timber harvest activities. The most common forms of monitoring required under the Waiver are agency monitoring, implementation monitoring, forensic monitoring, effectiveness monitoring, and photo-point monitoring. In rare instances, landowners may be required to do water quality compliance monitoring, assessment monitoring, and/or trend monitoring. **Figure 9 provides the landowner with a quick way to determine monitoring requirements and Figure 10 illustrates the timelines for each type of monitoring.**

The various types of monitoring are described below:

4.1. Agency Monitoring:

Agency monitoring is required for all Waiver categories (Figure 9), but since it is done by regulatory agencies it requires little effort by landowners. Agency monitoring is monitoring conducted by the California Department of Forestry (CDF) and the Regional Board on private lands, and the United States Forest Service (USFS) on federal lands. These agencies evaluate compliance with CDF's Forest Practice Rules or USFS best management practices (BMP) guidance documents. Even though the landowner does not do agency monitoring, landowners should request a written record of any agency inspection done throughout the life of the project, with the exception of Regional Board monitoring reports, and submit it in their annual report. Agency monitoring must be done before November 15 to be used in place of implementation monitoring.

4.2. Implementation Monitoring:

The most important type of monitoring is implementation monitoring. Implementation monitoring is typically required for Waiver categories 2 through 5 (Figure 9). Implementation monitoring determines whether management measures were carried out as planned. In simple terms, implementation monitoring answers the question, "Did we do what we said we were going to do?" Implementation monitoring consists of detailed visual monitoring of hillslope features (i.e., roads, landings, skid trails, watercourse crossings, WLPZs, and unstable areas); with emphasis placed on determining if management measures (such as erosion control measures, riparian buffers) were implemented or installed in accordance with approved timber harvest projects. This type of monitoring specifically addresses whether management measures were implemented according to the Forest Practice Rules, THP language, Regional Board recommendations, and Waiver criteria. Special focus should be placed on evaluating the implementation of recommendations made by Regional Board staff during pre-harvest inspections (PHIs).

Implementation monitoring may include photo-documentation of installed management measures (photo-point monitoring). A "final compliance report" or "work completion report" inspection, conducted by CDF prior to the winter period and after cessation of active harvesting and road construction, may be substituted for the required pre-winter inspection if the inspection covers the entire plan area and the report is submitted to the Regional Board before December 1.

Implementation inspections should only be conducted where timber harvest activities have taken place. For THP areas with actively logged areas, implementation inspections shall be conducted as follows:

- *Where timber harvest activities have started and no winter operations are planned* – A pre-winter implementation inspection shall be completed by November 15 of each year.
- *Where timber harvest activities have started and winter operations are planned* – A pre-winter implementation inspection shall be completed by November 15 of each year for areas not subject to winter operations. Also, an implementation inspection shall be completed immediately following cessation of winter period operations in areas where winter operations occurred.

Once you've determined the portions of the THP area that have the highest risk to water quality, it will be necessary to determine if management measures (i.e., mitigations and best management practices) have been implemented in these areas prior to the winter season.

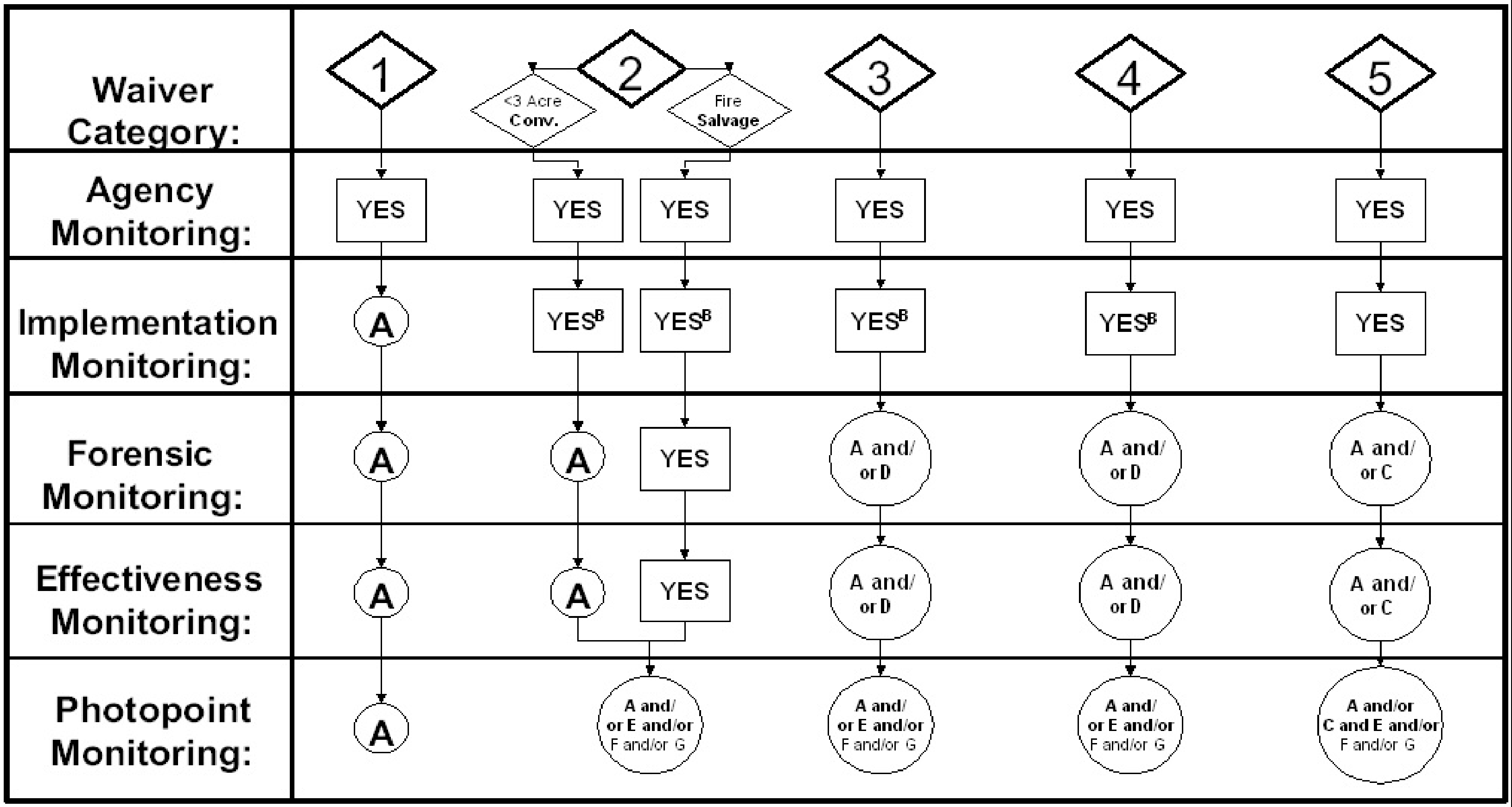
The things to consider when determining if management measures are properly implemented are the following:

4.2.1. Unstable Areas

Avoidance is the typical mitigation when operating near unstable areas. However, operations within unstable areas can be permitted if explained and justified in the THP. If unstable areas are present within the THP area, inspect for the following:

- ***Were the unstable areas avoided during timber harvest activities?*** Unless allowed in the THP, make sure that timber harvest activities did not occur within the unstable areas.

- ***Make sure that timber harvest activities do not cause runoff to be drained into unstable areas.*** Make sure that waterbreaks on roads, skid trails, or cable roads drain water away from unstable areas.



A - At request of Executive Officer.

B - CDF completion report may be substituted if submitted by Dec-1.

C - Required when USFS projects over the past 10 years have resulted in the planning watershed exceeding the threshold of concern

D - Required unless the following conditions are met: 1) No constructed or reconstructed Class 1, 2, or 4 (domestic use) watercourse xings; 2) No ground based equipment operations within Class 1, 2, or 4 (domestic use) WLPZs; 3) No winter ops. within any Class 1, 2, 4 (domestic use) WLPZs or on areas with high or extreme EHRs; 4) No road construction or re-construction within 500 ft. of a Class 1, 2, or 4 (domestic use) watercourse; 5) No landing construction or re-construction within Class 1, 2, or 4 (domestic use) WLPZs; 6) No heavy equipment ops. on areas classified high or extreme EHR that have potential to impact water quality; 7) No " in-lieu" or "alternative" practices that have the potential to impact water quality; 8) No ground-based equipment on slopes >65% or slopes >50% classified as high or extreme EHR.

E - Required for implementation monitoring if harvest proposed on: 1) Extreme EHR; 2) Unstable areas; 3) Crossings with 500 cubic yards of fill or 25 vertical feet of fill.

F - Required for forensic monitoring if ten cubic yards or more is delivered to watercourses;

G - Required for effectiveness monitoring if significant discharge of sediment occurs to Class I (fish bearing for Forest Service) or Class II watercourses (perennial for Forest Service).

Figure 9. Monitoring requirements by Waiver category.

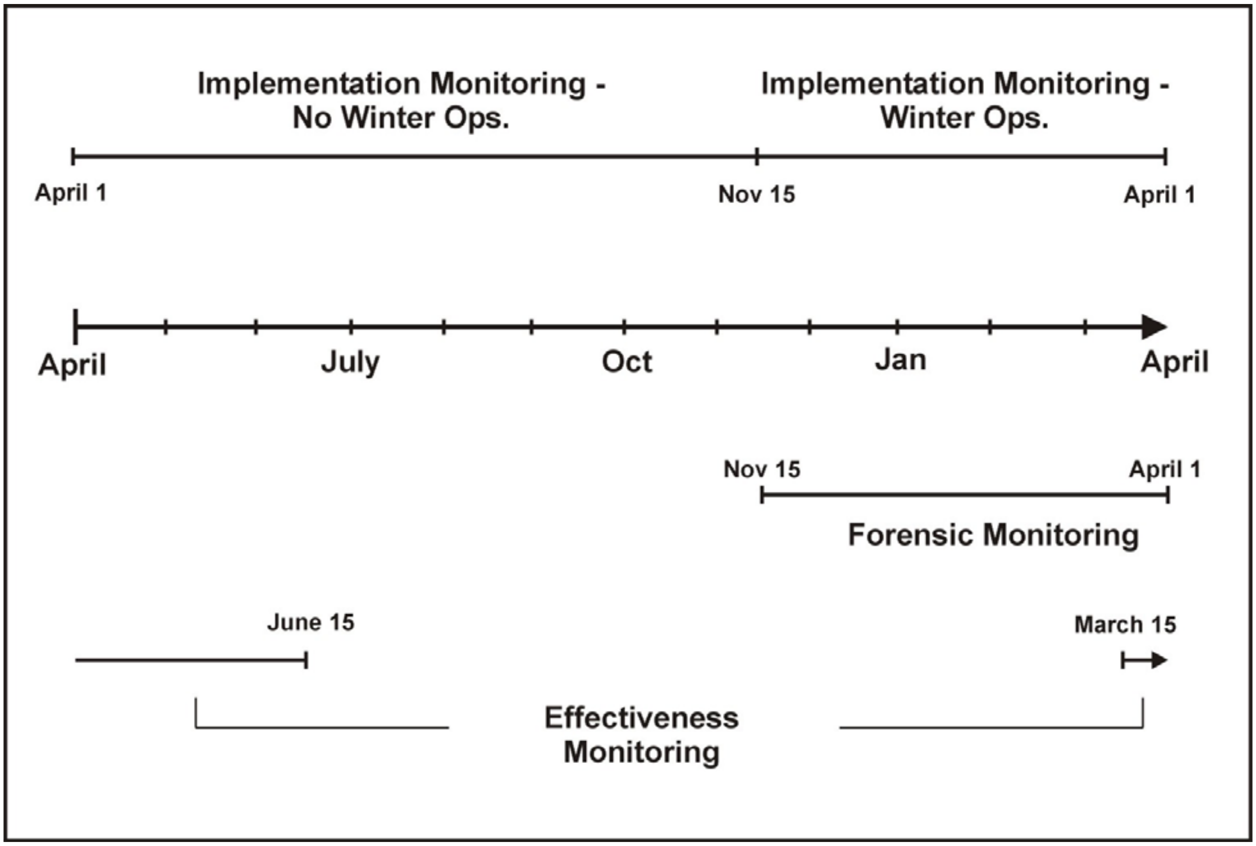


Figure 10. Timelines for Waiver monitoring.

- ***If timber harvest activities are permitted within unstable areas, make sure that site-specific mitigations listed in the THP are implemented.*** If the use of ground based equipment is proposed within unstable areas, site-specific mitigations will be listed in Section II, Item 21.a. of the paper THP. If roads are proposed for construction or reconstruction in unstable areas, site-specific mitigations will be listed in Section II, Item 24.b. If landings are proposed for construction or reconstruction in unstable areas, site-specific mitigations will be listed in Section II, Item 24.i.

4.2.2. Road-Stream Crossings

Check stream crossings to determine if management measures are implemented correctly. If Section II.26.c. of the paper copy of the THP is checked yes, then you will have to check to see if the culvert(s) and associated fills were installed and constructed consistent with the THP language and the California Forest Practice Rules (http://www.fire.ca.gov/php/rsrc-mgt_content/downloads/2006FPRulebookwithDiagrams.pdf - page2). Inspect for the following at newly-constructed or reconstructed crossings:

- ***If a new culvert is installed, is the diameter of the culvert the same size or larger than the diameter specified in the plan[1]?*** Check Section II.26. of the THP to see if the diameter of the newly installed culvert is consistent with diameter specified in the plan.

- ***Has the culvert been installed along the natural grade of the channel (see Figure 11)?*** Culverts that are not installed along the natural channel grade can cause deposition of sediment at the inlet, road fill erosion, channel erosion, and prevent fish passage.

Figure 11. A picture of a culvert that was not set to the natural grade of the channel. These culverts are often referred to as “shotgunned” culverts.

- ***Is the culvert properly aligned with the channel?*** Culverts that are not properly aligned with the channel are more susceptible to plugging by sediment and debris (Figure 12).

- ***If inlet scour is a potential issue, is the inlet properly armored against scour?*** Scour is erosion by water current. To determine if inlet scour is an issue, look at the average size of rock in the channel above the influence of the crossing. If it is much larger than the fill material or rock armor, then the inlet is not adequately protected against scour. Armor should be placed below the point of scour, keyed into the fill to increase stability, and be sized to resist flow velocities during the 100-year flood (Figure 13).

[1] The crossing must also be appropriately sized for the 100-year flood.

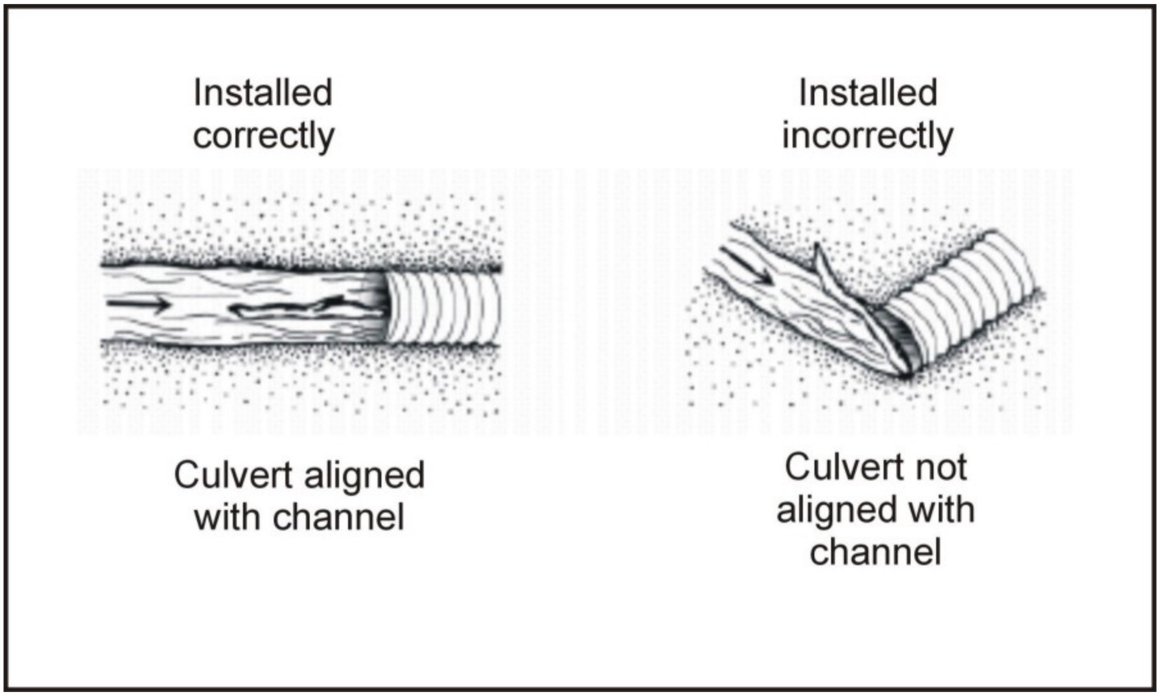


Figure 12. A schematic showing the proper and improper alignment for a culvert (Furniss et al., 1997).

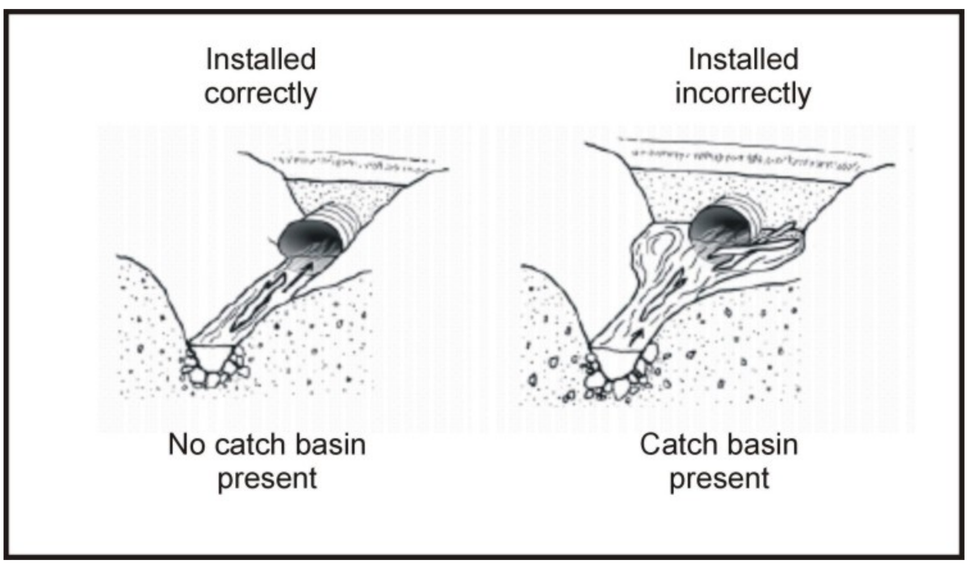
Figure 13. An illustration of inlet armoring. The crossing is on a large channel and therefore requires large rock for armoring (from Kellar and Sherar, 2003).

- ***If water is discharged onto the fillslope, is the fillslope adequately armored to prevent erosion?*** Fill erosion is common below shotgunned culverts (Figure 14). Rock armor on the fillslope should be of sufficient size to not be transported during the 100-year flood.

- ***Do conditions at the culvert inlet promote sediment deposition?*** Sediment deposition at the culvert inlet can cause culvert plugging. For example, has the channel been widened above culvert inlet? A widened channel above a culvert inlet is referred to as a "catch basin" (Figure 15).

Figure 14. Picture showing inadequate armoring of fillslope below a shotgunned culvert (from Kellar and Sherar, 2003). Fillslope armoring is a necessary mitigation when culverts cannot be set to grade.

Figure 15. Illustration of proper and improper inlet geometry (Furniss et al., 1997)

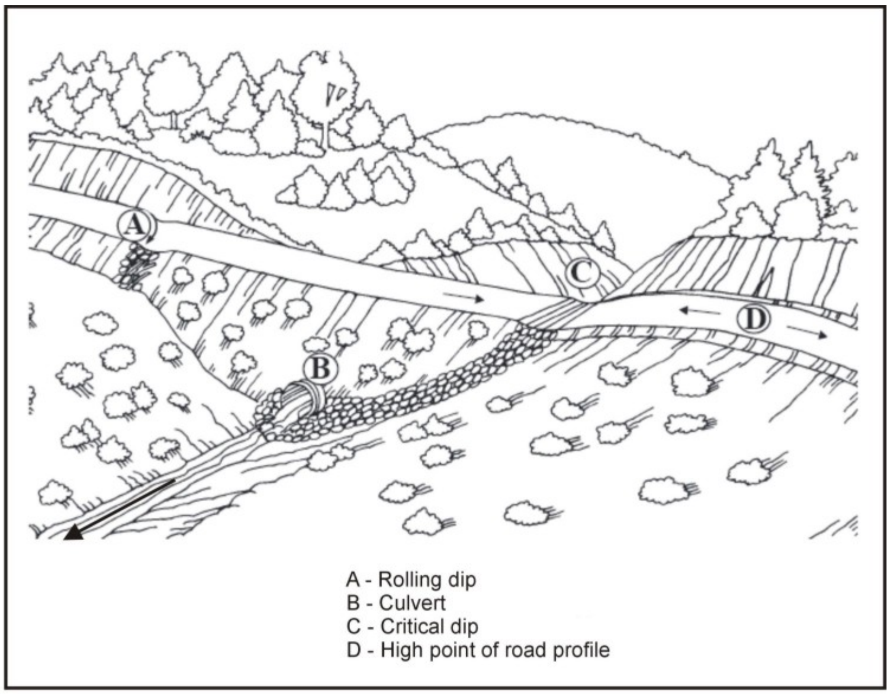


- ***If necessary, is a critical dip present to prevent the likelihood of stream diversion?*** A properly installed critical dip, or other overflow structure, should be on the downhill side of all crossings (Figure 16). Make sure that the critical dip is built to the specifications listed in the THP, and that the outlet side of the critical dip is armored with rock sufficiently large enough not to be transported during the 100-year flood.

- ***Is road runoff disconnected before it reaches the watercourse crossing?*** For example, are waterbreaks (i.e., rolling dips or waterbars) placed on the approaches to the crossing so that runoff and sediment does not reach the watercourse (Figure 16)? It is virtually impossible to disconnect all of the road drainage from the watercourse. However, the length of road draining to the stream should be kept to a minimum.

- ***If road surfacing (i.e., rock aggregate) is to be used near or at the watercourse crossing, is it done to the specification listed in the THP?*** At the minimum, rocking should be done at the diameter, depth, and extent listed in the THP.

Figure 16. Illustration of a critical dip with rocked outfall (Point C). Arrows represent the flow of runoff. The rolling dip uphill of the crossing (Point A) helps to prevent sediment delivery at the crossing. Point D illustrates how a properly designed road can help prevent road runoff and sediment from delivering to the watercourse (adapted from Kellar and Sherar, 2003).



- **If the crossing is temporary, has the fill been excavated to form a channel that is as close as feasible to the natural watercourse grade and orientation, and that is wider than the natural channel (Figure 17)?** If all the fill material is not removed, the channel will downcut through the fill material and possibly result in significant sediment discharge. Widening the channel prevents the banks of the channel from sloughing into the channel.

- ***Has excavated material or bare soil adjacent to the crossing been stabilized as per item 18 of the THP to prevent surface erosion?*** The abandoned crossing must be stabilized as per item 18 of the THP to prevent sediment from entering the channel (Figure 17).

4.2.3. Watercourse and Lake Protection Zones and Equipment Limitation Zones
Watercourse and lake protection zones (WLPZs) and equipment limitation zones (ELZs) protect water temperature and/or filter sediment before it reaches a watercourse.

- ***Are the widths of the WLPZs and ELZs consistent with those specified in the THP?*** WLPZ and ELZ widths are based on the stream classification (i.e., Class I through IV), slope gradient (Table 2), yarding practices, and whether the watershed is listed as “threatened or impaired” (i.e., T&I).
- ***Is the canopy left in the WLPZ consistent with those specified in the Forest Practice Rules?*** Canopy requirements in WLPZs are dependent on the stream classification and whether the watershed is listed as “threatened and impaired” (Table 2).

Figure 17. An abandoned and stabilized watercourse crossing. The culvert has been removed, and the fill has been pulled back and stabilized. The banks have been stabilized with straw mulch.

Watercourse Classification	Slope Gradient	Buffer Width	Overstory Canopy Requirement	Understory Canopy Requirement
Class I	<30 30-50 >50	75 100 150 for tractor / 100 for cable	≥50%	≥50%
Class II	<30 30-50 >50	50 75 100 for tractor / 75 for cable	≥25%	≥25%
Class III	<30 >30	>25 >50	none	≥50%
Class IV	see THP	see THP	see THP	see THP

Table 2. Watercourse and lake protection zone (WLPZ) and equipment limitation zone (ELZ) widths and protection measures by watercourse classification. WLPZ and ELZ widths and protection measures might be different if the watershed is listed as "threatened and impaired" (see section 916.9 of the California Forest Practice Rules).

4.2.4. Roads and Landings

Roads and landings pose a potential threat to water quality if they are close to a watercourse or are on steep slopes above a watercourse. Impacts include chronic inputs of fine sediment and an increased potential for landsliding.

- ***If more than 100 feet of road is constructed on slopes greater than 65%, make sure that excess fill or sidecast is not placed below the road.*** Excess fill or sidecast on steep slopes can cause landsliding.

- ***Make sure that waterbreaks on roads are at the correct spacing and are properly constructed.*** Waterbreak spacing for roads is based on the steepness of the road and the estimated erosion hazard rating (Table 2; Figure 18). Site-specific recommendations on waterbreak spacing may also be listed in Section II, Item 25 of the THP. Waterbreaks should be at least 12 inches in height.

Table 3. Waterbreak spacing by erosion hazard rating and road/skid trail gradient

Erosion Hazard Rating	Road or Skid Trail Gradient (%)			
	<10	**11-25**	**26-50**	**>50**
Extreme	100 ft	75 ft	50 ft	50 ft
High	150 ft	100 ft	75 ft	50 ft
Moderate	200 ft	150 ft	100 ft	75 ft
Low	300 ft	200 ft	150 ft	100 ft

- ***If road construction results in excess material (i.e., fill or sidecast), is the excess material deposited and stabilized so that it poses a minimal risk to water quality.*** If it poses a risk to water quality, excess material from road construction and grading should be stabilized. This may include mulching the excess material with straw or slash, sloping back the excess material to a stable angle, or hauling the excess material to a location that is stable, well drained, and isolated from wet areas or watercourses.

- ***If drainage structures and drainage facilities on logging roads discharge runoff onto erodible fill or soils, make sure that energy dissipators are placed below the road drainage outlets so that sediment transport is minimized.*** The placement of energy dissipators is most important when roads are within 300 feet of a watercourse and if long stretches of road are being drained onto the hillslope.

Figure 18. A picture of a rolling dip on an outsloped haul road. Arrows represent the flow of runoff (from Kellar and Sherar, 2003).

4.2.5. Tractor Crossings

Tractor crossings can deliver sediment to watercourses if they are not removed or stabilized.

- ***Has the tractor crossing been removed prior to the winter period?*** Unless the crossing is permanent, it must be removed from the watercourse before November 15th, or otherwise specified in the THP.

- ***If the crossing is removed, has the fill been excavated to form a channel that is as close as feasible to the natural watercourse grade and orientation?*** Has the use of the tractor crossing caused extensive bank or channel damage? Has the excavated material or bare soil been stabilized to prevent slumping and to minimize soil erosion?

- ***Have the approaches to the skid crossing been disconnected and stabilized to prevent the delivery of sediment to the watercourse?*** It is virtually impossible to disconnect all of the skid trail drainage from the watercourse. However, the length of skid trail draining to the stream should be kept at a minimum.

4.2.6. Tractor Operations

Tractor operations can impact water quality if they occur close to watercourses and/or on steep slopes.

- ***Did tractor operations occur on slopes steeper than those allowed by the Forest Practice Rules, and which pose a threat to water quality?*** For example, did tractor operations occur on slopes greater than 50% that lead without flattening to a watercourse or lake?

- ***Make sure that waterbreaks are put in at the correct spacing on skid trails and are properly constructed*** (Figure 19)***.*** Waterbreak spacing for skid trails is based on the steepness of the skid trail and the estimated erosion hazard rating. For proper waterbreak spacing on skid trails see Table 2. Site-specific recommendations on waterbreak spacing may also be listed in Section II, Item 21 of the THP.

4.2.7. Site Preparation

- ***Is concentrated water from roads, landings, skid trails, and firebreaks, drained onto site preparation areas in close proximity to watercourses?*** If so, make sure that energy dissipators are placed below the outlet of the waterbreak.

- ***If contour ripping is used, make sure that the slope is ripped perpendicular to the fall line (i.e., the downhill direction) of the slope.***

Figure 19. Waterbars on a skid trail. Arrows indicate the flow of water. The waterbar at the bottom of the picture was not constructed properly and as a result will reroute runoff onto the skid trail (Kellar and Sherar, 2003).

4.3. Forensic Monitoring:

Forensic monitoring is generally required for Waiver categories 3 and 4, and for Notice of Emergency Timber Operations related to fire salvage (Figure 9). Forensic monitoring determines whether significant pollution is being generated by hillslope features such as roads, landings, skid trails, watercourse crossings, and unstable areas. In short, forensic monitoring answers the question, "Did our implemented management measures hold up well during winter storms?"

Forensic monitoring employs visual field detection techniques to detect significant pollution caused by failed management measures, failure to implement necessary measures, problems related to legacy timber activities, non-timber related land disturbances and natural sediment sources. Forensic monitoring should include photo-point monitoring to document pollution sources. Forensic monitoring is typically applied at the hillslope and watershed scale, and is conducted by the discharger.

If forensic monitoring is required (Figure 9), it must be conducted at least two times during each winter period that the THP is enrolled in the Waiver once timber operations have begun. Forensic monitoring will take place:

- Once, during or within 12 hours following a 24-hour storm total of at least 2 inches (of rainfall) and after 5 inches (of total precipitation) has accumulated after November 15 and before April 1.
- Once, during or within 12 hours following a 24-hour storm total of at least 2 inches (of rainfall) and after 15 inches (of total precipitation) has accumulated after November 15 and before April 1.
- If a noticeable significant discharge of sediment is observed at any time in any Class I or Class II watercourse. Photo-point monitoring shall be conducted when such discharge is the result of failed water quality protection measure(s) or lack of implementation of such measure(s).

Figure 20 demonstrates the timelines for forensic monitoring as related to storm precipitation and accumulated precipitation. Inspections that cannot be conducted during or within 12 hours of such a storm event (due to worker safety, access, or other uncontrollable factors) shall be conducted as soon as possible thereafter and will be noted in the annual report.

Landowners must determine 24-hour rainfall totals and accumulated precipitation as of November 15th in order to determine when to do forensic monitoring. Regional 24-hour rainfall data can be accessed from the California Data Exchange Center (CDEC) (http://cdec.water.ca.gov/precip_maps/)(Figure 24). To find the closest precipitation gaging stations to your THP area use the following link (http://cdec.water.ca.gov/cgi-progs/mapper).

It is critical to do forensic monitoring during the storm event, or shortly after the storm event (i.e., within 12 hours). This is because significant pollution can often occur relatively early in a storm event, and can be missed if monitoring is done too long after the storm ends. If forensic monitoring can’t be done during this critical time frame, it is easier to determine if significant pollution has taken place when forensic inspections are done at hillslope scale. This is because evidence of significant pollution (i.e., rills; gullies; landslides) can usually be observed in the field. Forensic monitoring at the watershed scale should not be done if the monitoring time frame is missed.

Hillslope scale forensic monitoring should focus in the following THP areas:

1. Timber harvest activities within or near unstable areas;
2. Constructed or re-constructed Class I, II, or Class IV (with domestic use) crossings;
3. Class I, II, or IV (with domestic use) watercourse and lake protection zones where ground based equipment operations have occurred (i.e., tractor crossings);
4. Road construction or reconstruction within 500 feet of a Class I, II, or IV (with domestic use) watercourse;
5. Landing construction or re-construction within Class I, II, or IV (with domestic use) watercourses;

6. Ground-based equipment on areas classified as high or extreme erosion hazard rating that have the potential to impact water quality;
7. Ground-based equipment on slopes greater than 65% or slopes over 50% classified as high or extreme erosion hazard rating;
8. Areas where “In-lieu” or “alternative” practices that have the potential to impact water quality.

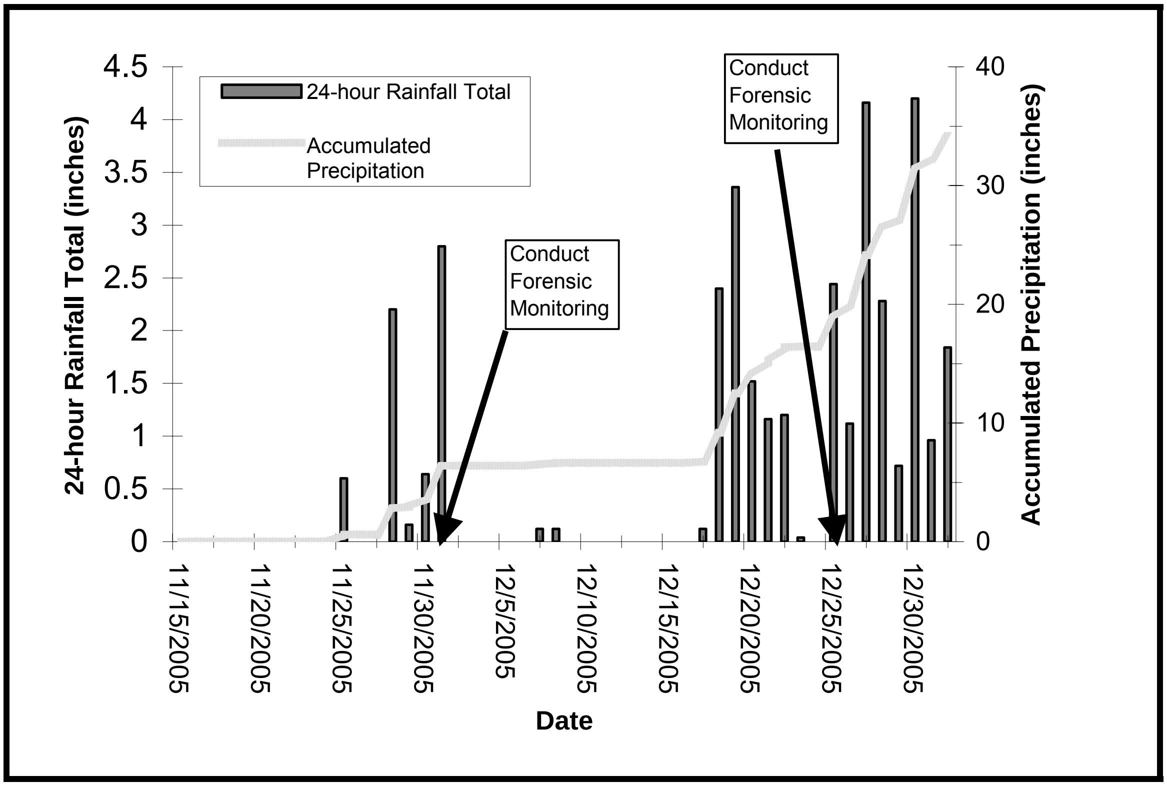


Figure 20. A graph detailing the timeline for forensic monitoring. The 24-hour rainfall totals and accumulated precipitation are for the Brandy Creek raingage. Arrows indicate dates of forensic monitoring.

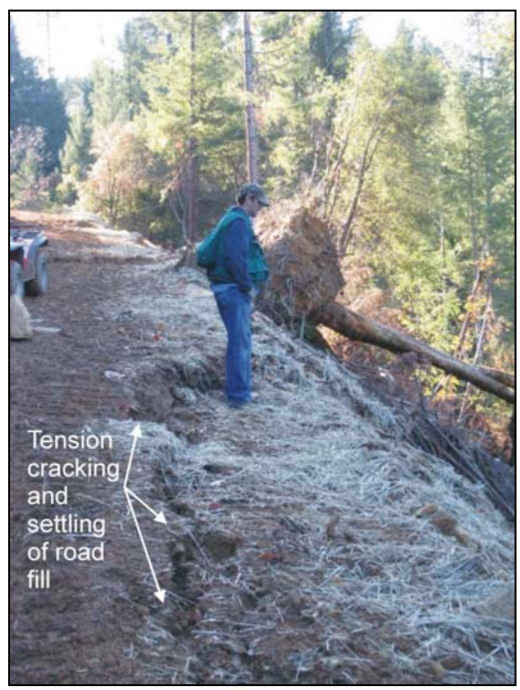
When conducting forensic monitoring in these areas, look for erosion features (rills; gullies; landslides) that transport sediment to a watercourse. If failed management measures cause, or may cause, 10 or more cubic yards of sediment delivery to a watercourse, then forensic photo-point monitoring is required. Common erosion features associated with timber harvest activities after large storms may include:

- **Landsliding associated with timber harvest activity.** Landslides can be initiated by road drainage or skid trail drainage (Figure 21), or by perched fill material or sidecast. Report all landsliding associated with timber harvest activities.

Figure 21. Landslide caused by diverted skid trail runoff. The landslide delivered to a Class I watercourse.

- **Tension cracking or settling on road fill or sidecast.** Tension cracks on road fill or sidecast indicates that landsliding may occur (Figure 22). Report tension cracking of road fills and sidecast if the delivery to a watercourse is likely.

Figure 22. Picture shows tension cracks on the outside edge of the road fill. In addition, the fill material has settled approximately one foot. Tension cracks and road settling are indicators that the fill material is unstable. If the hillslope is steep enough unstable fill material may result in landsliding.



- **Erosion voids at road crossings.** Erosion voids may occur near the inlet or outlet of the crossing (Figure 23). In some cases where the inlet of the culvert becomes plugged, runoff overtops the crossing and most of the fill material above the outlet of the culvert can be washed away.

Figure 23. An erosion void near the outlet of a road crossing (from http://www.tcrcd.net/images/sftr_erosion2.jpg).

- **Extensive rilling or gullying of road surfaces, road fills, and landings that deliver or may directly to a watercourse** (Figure 24). Water quality impacts can occur when rills or gullies develop on the approaches to a road-stream crossing or the fill material at a road-stream crossing.

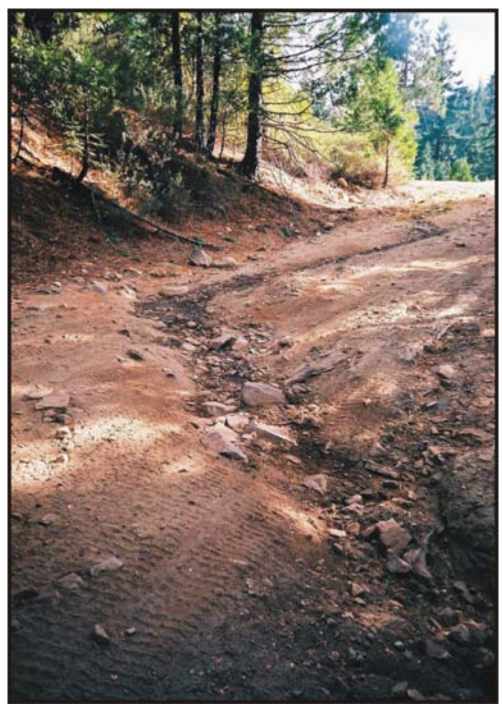


Figure 24. An example of rilling on a road surface. This might be considered significant pollution if it delivered directly to a watercourse. Erosion impacts can addressed by correcting road drainage.

- **Gullies on or below poorly drained roads or skid trails that deliver or may deliver directly to a watercourse**. This is typically caused by insufficient drainage on the road or skid trail (Figure 28).

Figure 25. Gully initiated by tractor logging.

If forensic monitoring is done when runoff is still relatively high, then instream monitoring can be used to detect sources of significant pollution. Inspect watercourses that drain large portions of the THP area. If the water is muddy, check to see if noticeable sediment is coming from any hillslope features within the watershed. Cause-and-effect can be determined if the water becomes noticeably muddy below a hillslope feature such as a road crossing or unstable area.

4.4. Effectiveness Monitoring:

Effectiveness monitoring is generally required for Waiver categories 3 and 4, and for Notice of Emergency Timber Operations related to fire salvage (Figure 9). Effectiveness monitoring consists of visual monitoring to evaluate whether particular management measures were successful in preventing significant pollution during the previous winter period. The timeframe for monitoring is March 15th to June 15th. Effectiveness monitoring is conducted by the discharger (i.e., landowner) through site inspections.

Effectiveness monitoring may be applied at a range of spatial scales. Effectiveness monitoring may include visual hillslope monitoring (observations on the harvested slopes) or visual instream monitoring (evaluation of instream conditions). However, effectiveness monitoring is best done at the hillslope scale.

Effectiveness monitoring is essentially the same as forensic monitoring, except it's done at the end of the winter period or after. Management measures are considered to be effective if they result in no significant pollution or have little risk of significant pollution. As in implementation monitoring, the landowner should look at the following hillslope features and inspect them for signs of sediment delivery to watercourses.

1. Timber harvest activities within or near unstable areas;
2. Constructed or re-constructed Class I, II, or Class IV (with domestic use) crossings;
3. Class I, II, or IV (with domestic use) watercourse and lake protection zones where ground based equipment operations have occurred (i.e., tractor crossings);
4. Road construction or reconstruction within 500 feet of a Class I, II, or IV (with domestic use) watercourse;
5. Landing construction or re-construction within Class I, II, or IV (with domestic use) watercourses;
6. Ground-based equipment on areas classified as high or extreme erosion hazard rating that have the potential to impact water quality;
7. Ground-based equipment on slopes greater than 65% or slopes over 50% classified as high or extreme erosion hazard rating;
8. Areas where "In-lieu" or "alternative" practices that have the potential to impact water quality.

When conducting effectiveness monitoring in these areas, look for erosion features (rills; gullies; landslides) that transport sediment to a watercourse. If failed management measures cause, or may cause, 10 or more cubic yards of sediment to be delivered to a watercourse, than a visual inspection of instream conditions is needed.

4.5. Photo-Point Monitoring:

Photo-point monitoring is generally not required for most landowners, except under special circumstances (Figure 9). Photo-point monitoring is a component of implementation, forensic, and effectiveness monitoring. For more information on photo-point monitoring see the Guidelines for Photo-point Monitoring.